California
Department of
Conservation
CalGEM

CES Class VI Permit Application Review

October 20, 2020

Overview

- Site Characterization Evaluation
- AOR and Corrective Action
- Testing and Monitoring
- Recommendation of Additional Risk Analyses
- Subsidence
- Injection Well Construction

Site Characterization Evaluation

Faults and Fractures

There is still some uncertainty about faults and fractures in the target area.

Recommendation:

- Perform fault slip/activation risk analysis if some existing faults could be at risk due to CO2 injection, once additional site-specific data are collected. In addition to fault seal analysis, fault slip/activation risks should be evaluated, especially for those major faults penetrating the reservoir and caprock.

Fault slip/activation risk can cause CO2 containment issues.

Site Characterization Evaluation

Geomechanical and Petrophysical Information

Geomechnical properties are essential to investigate the associate integrity risks.

Recommendation:

- Page 51 indicates that the dynamic elastic properties are computed based on density and sonic log data, however, static properties should be used for risk analysis. Therefore, conversion from dynamic parameter to the static parameter should be performed based on core measurement and log interpretation.
- Page 51 mentions confining stress of 5000 psi, however, when performing the laboratory triaxial test, confining stress that represents the reservoir condition should be applied.
- Please improve the quality of Figure 40 for readable y-axis titles and labels.

AOR and Corrective Action

Porosity and Permeability

It is stated on page 9 of Attachment B that vertical permeability is assumed to be equal to 10 % of the horizontal permeability.

Questions/Recommendations:

- Why is the vertical permeability assumed to be 10% of the horizontal permeability? The vertical permeability controls the vertical upward movement of the CO2 plume, which tends to move upward due to density contrast.
- Due to uncertainty of permeability for both target formation and seal formation, sensitivity analysis of the permeability in both target formation and caprock is recommended to make sure the injected fluid is contained within the target zone.
- Please add key formation markers and injection interval to both Figure 3 and Figure 4 of Attachment B.

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Fracture Pressure and Fracture Gradient

A fracture gradient of 0.65 psi/ft is assumed in the analysis as stated on page 17 of Attachment B.

Questions/Recommendations:

- To get a more reliable estimation, log data from nearby wells within 3 miles radius can be used to estimate rock properties and fracture gradient. For example, sonic log data is available for Well API# 01920752.
- The fracture gradient should be updated once on-site data (log data and well testing data) are available.

AOR and Corrective Action

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Injection and USDW Pressures

A “critical pressure” of 3.5 psi was determined in Section 4.1 of the AOR submission. Groundwater withdrawal continues. Both reservoir and USDW pressures are estimates subject to error.

Questions/Recommendations:

- What Federal regulations apply in the event of an “infinite” ZEI?

Computational Modeling Results

The AoR after 20 years of injection and 50 years of post-injection based on modeling results (the maximum extent of the plume and pressure front) were presented.

Questions/Recommendations:

- Please provide a 3D view of the CO2 plume migration with times.
- Please provide pressure distribution (3D view) with time plots (or delta P) from the simulation results.

Testing and Monitoring

Questions/Recommendations:

- The minimum recording frequency of 5 min in Table 2 of Attachment C seems long. A 1 minute recording frequency is suggested.

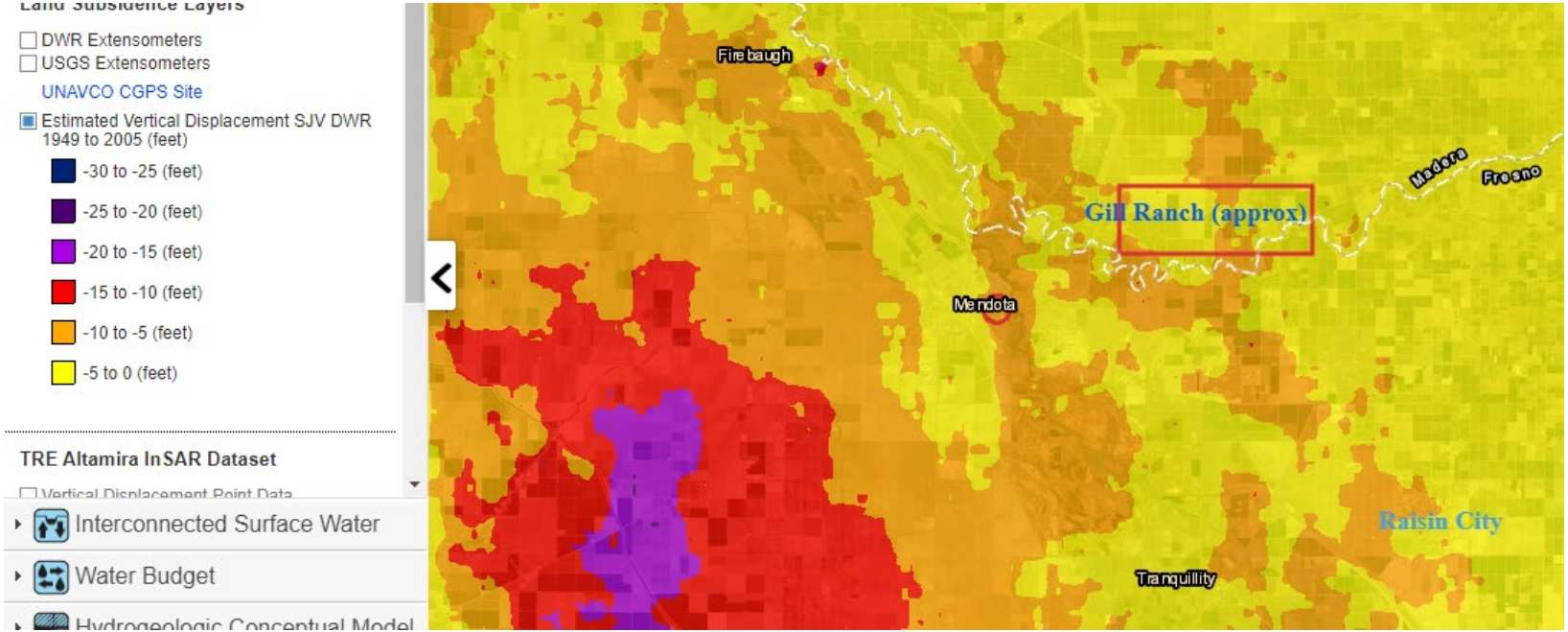
Recommendation of Additional Risk Analyses

A comprehensive analysis of risks associated with CO2 injection operation should be performed.

Recommendations:

- Evaluate target formation and surface uplift induced by CO2 injection. Depending on the injection depth, formation properties, and the magnitude of reservoir pressure change, long term CO2 injection could result in various reservoir and surface deformation. Bending of the caprock during uplift may lead to the development of shear stresses at the top of the caprock which could potentially result in caprock integrity issue.
- Evaluate caprock integrity risk. This kind of analysis assesses the likelihood of caprock failure that could cause potential leakage during CO2 injection through the caprock. The three primary leakage mechanisms include tensile fracturing of the caprock, fault activation, and well damage.

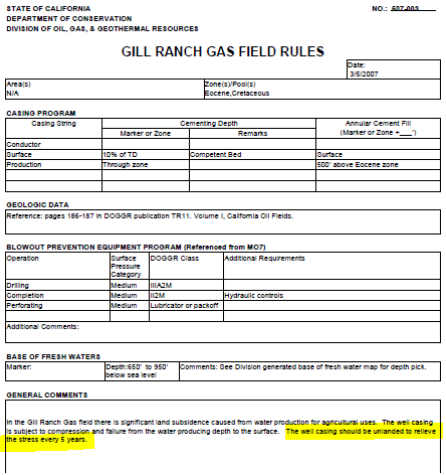
56 Year Subsidence from SGMA Viewer



Nearby Gill Ranch Field Rules

GENERAL COMMENTS

In the Gill Ranch Gas field there is significant land subsidence caused from water production for agricultural uses. The well casing is subject to compression and failure from the water producing depth to the surface. The well casing should be unlanded to relieve the stress every 5 years.



STATE OF CALIFORNIA
DEPARTMENT OF CONSERVATION
DIVISION OF OIL, GAS, & GEOTHERMAL RESOURCES

NO.: 507-003

GILL RANCH GAS FIELD RULES

Date: 3/6/2007

Area(s)	Zone(s)/Pool(s)
N/A	Eocene,Cretaceous

CASING PROGRAM

Casing String	Cementing Depth		Annular Cement Fill
	Marker or Zone	Remarks	(Marker or Zone +___ ')
Conductor			
Surface	10% of TD	Competent Bed	Surface
Production	Through zone		500' above Eocene zone

GEOLOGIC DATA

Reference: pages 186-187 in DOGGR publication TR11, Volume I, California Oil Fields.

BLOWOUT PREVENTION EQUIPMENT PROGRAM (Referenced from MO7)

Operation	Surface Pressure Category	DOGGR Class	Additional Requirements
Drilling	Medium	IIIA2M	
Completion	Medium	II2M	Hydraulic controls
Perforating	Medium	Lubricator or packoff	

Additional Comments:

BASE OF FRESH WATERS

Marker:	Depth:650' to 950' below sea level	Comments: See Division generated base of fresh water map for depth pick.

GENERAL COMMENTS

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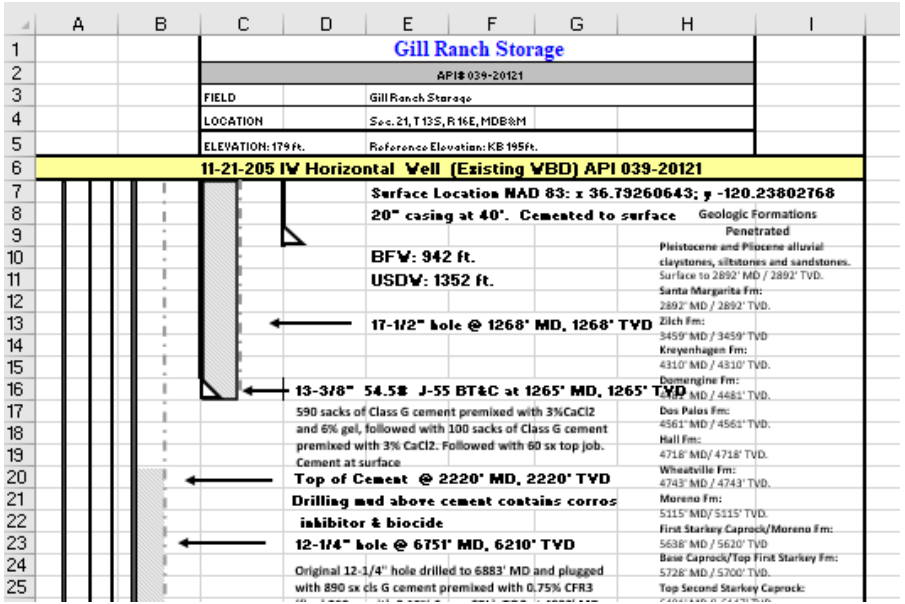
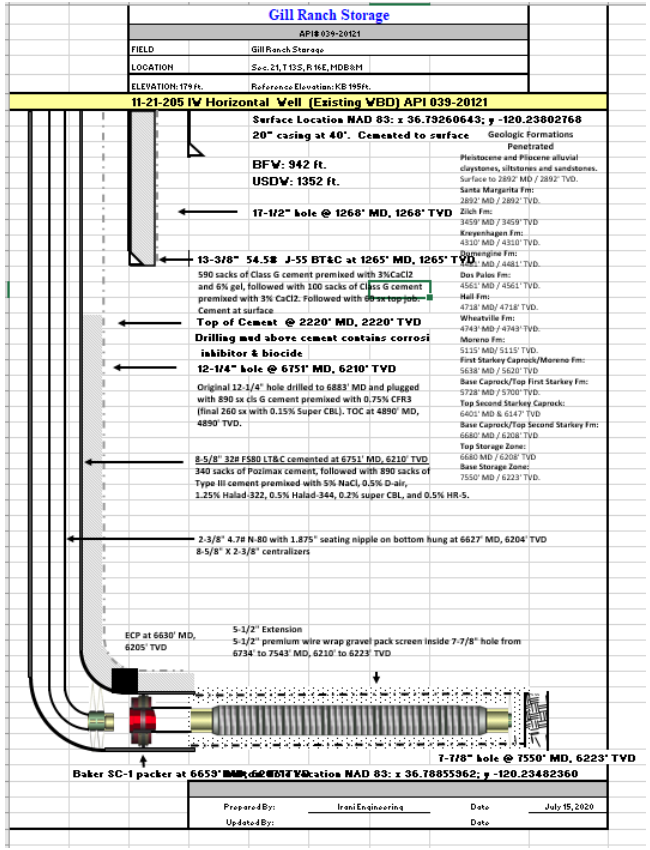
Preferred Subsidence Mitigation – Current Practice



Allows movement between outer casing and remainder of well.



Well Construction Questions:

- Can Schlumberger modify well designs to mitigate shallow compression while adhering to Federal Class VI regulations ?

- Does Schlumberger have corrosion performance data on 13% Cr in C02 with 1% oxygen?

- Are capillary tubes used for installation of either fiberoptics or other equipment external to the casing? If so, what is their internal diameter, and how will they be plugged at the end of well life?

- At what frequency will the SSSV shown in the completion diagram be tested?

THANK YOU

Questions?